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THE ORIGIN OF SPECIES BY MUTATION *

By D. T. MacDougal

As a result of previous studies, de Vries was led to believe that species with a tendency to form monstrosities would be most likely to offer opportunities for securing evidence of the origin of new species by mutations or discontinuous variations. A thorough inspection of promising forms around Amsterdam in Holland was begun in 1886 and carried on for several years, during which period more than a hundred species were brought under cultivation, only one of which was found useful for observations upon mutations.

The plant in question—*Onagra biennis* (L.) Scop. [*Oenothera Lamarckiana*]—had escaped from cultivation in this locality in 1875 and was represented by several hundred examples in an old potato field. The rapid multiplication of the individuals had been accompanied by many divergences from typical forms inclusive of ascidia and fasciations, and while many were annuals, others were clearly biennial and a few were triennials. In 1887, a number of individuals representing two forms so distinct from *O. biennis* as to constitute new elementary species were found in the multitude of individuals which were examined. The exact origin of the new types, which were named *Oenothera brevistylis* and *Oe. laevifolia*, could not of course be determined, but both were found to be constant from seeds; furthermore, no examples of similar forms could be found in the principal herbaria. The occurrence of the two forms in question was not conclusive evidence in itself but they served to bring the interest and enthu-

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siasm of the investigator to the highest pitch and induced him to plan a series of observations lasting through the following fourteen years, which entailed an enormous amount of tedious mechanical work.

The experimental investigations which followed were organized with an attention to detail that left nothing to chance and reduced the sources of error to a minimum. Without recounting all of the various features of the technique employed it will suffice to say that most rigid methods of isolation of specimens and regulation of pollination were used, a fact that adds much value to the results which were achieved.

The culture of the main species was carried through successive seasons from absolutely pure crops of seeds, and the derivative forms were cared for in the same manner. *Onagra biennis* was found to be in a state of mutation and to reproduce every year of the experimental tests a number of forms which might be designated as constituting new species. Nine species were thus found to spring from *O. biennis*, being designated as *gigas*, *albida*, *oblonga*, *rubrinervis*, *nanella*, *lata*, *scintillans*, *elliptica*, *leptocarpa*, *brevistylis* and *laevifolia*. Mutants or derived species also were found to be in a state of mutation to some extent, and *laevifolia* gave rise to *spathulata* in addition to some of the forms derived from the parent type. *O. lata* in a similar manner gave rise to *sublinearis* and *subovata* in addition to some of the forms also derived from the parent type. The following table will

A Group of Derivatives from *O. biennis*

Generation.	Name of Species																	
	gigas.		*albida.*		*oblonga.*		*rubrinervis.*		*biennis.*		*nanella.*		*lata.*		*scintillans.*			
VIII. 1899			5	—	1	—	0	—	1700	—	21							
									|								
VII. 1898					9	—	0	—	3000	—	11							
									|								
VI. 1897			11	—	29	—	3	—	1800	—	9	—	5	—	1			
									|								
V. 1896			25	—	135	—	20	—	8000	—	49	—	142	—	6			
									|								
IV. 1895	1	—	15	—	176	—	8	—	14000	—	60	—	73	—	1			
									|								
III. 1890–91							1	—	10000	—	3	—	3					
									|								
II. 1888–89									15000	—	5	—	5					
									|								
I. 1886–87									9									

illustrate the frequence and manner of occurrence of the mutants derived from pure seed cultures of *Onagra biennis* (*Oenothera Lamarckiana*) in a series extending from 1886 to 1899.

In the genealogical table shown above, seeds from the nine specimens of the first generation produced 15,000 of the parent type, 5 of *nanella* and 5 of *lata*. Seeds from some of the 15,000 produced a crop consisting of 10,000 *biennis*, 3 *nanella*, 3 *lata* and 1 *rubrinervis*. The succeeding generations were obtained in the same manner.

It is to be seen from the above table that in the series of cultures outlined above, embracing seven generations of seedlings, about 800 of the 50,000, or a little more than 1.5% of the entire number, were mutants or forms sufficiently divergent from the normal to be designated as new species. The parent type produced some of the new species every year it was under observation but by no means in the same proportion or profuseness, and it seems very probable that no plant will exhibit the tendency to produce mutants in greater degree than the one which has been selected for these notable experiments. It is also to be noted that the new species have by no means the strength and general virility of the parent type, and that the few individuals representing some of the new species in any community would have but little chance of survival in the struggle for existence with the thousands of their fellows of the parent type. When isolated, however, and relieved from the fiercer competition met under natural conditions, the majority were independent constant types. *O. scintillans*, *O. sublinearis* and *O. elliptica* were classed by de Vries as inconstant forms, while *O. lata* is sterile so far as the examples yet examined show.

A discussion of the facts given above could hardly be made without calling up the question at once as to the systematic value of the forms designated as species. The new species which suddenly originate do not differ so widely as an apple from a pear, or as a pine from a spruce; only in a few of the species are their general features strikingly divergent from the parent type. Yet a careful examination will show that differences are present and important, relating to size and aspect of the shoot, shape,

color and surfaces of the leaves, and size and form of the fruits. Some of the new species are separable in the seedling stage when three or four leaves have been formed, the rosette presenting a characteristic picture. De Vries suggests that the mutants or species derived by mutations in his experiments are quite as clearly separable as the species recognized in the currently accepted classifications of the oaks, hieraciums, or cochlearias.

(*To be continued.*)

OUR YELLOW LADY'S-SLIPPERS

By P. A. Rydberg

Some time ago I received a letter from Mr. Oakes Ames, of North Easton, Mass., which contained, among other matters, the following lines: "While looking over your revision of the Orchidaceae in Dr. Britton's 'Flora of the Northern States and Canada' (1901), I noticed that your key for the genus *Cypripedium* gives as a characteristic of *C. pubescens* (*hirsutum*) a pale yellow lip, flattened vertically, and as a characteristic of *Cypripedium parviflorum*, a bright yellow lip, flattened laterally. Have you found in working up your material that the case is reversed after all, and that Hooker, Gray and others were confused in their ideas?"

Although I revised the manuscript of the Orchidaceae for Dr. Britton's Manual, I did not find anything in the treatment of *Cypripedium* that I thought needed a change, but left that genus practically as Dr. Britton had it in the "Illustrated Flora." I added in this case the differences in the flattening of the lip, which character had been used here at the Garden. My understanding of the two species was, however, the same as that of Dr. Britton and I had no idea that Hooker, Gray or others had any other understanding. I thought, therefore, that the difference between the characteristics given by them and by us was more apparent than real and that it depended upon a different interpretation of terms. I, therefore, wrote to Mr. Ames, explaining my use of the words "vertically" and "laterally" flattened. By *vertically flattened*, I mean such a flattening as would be produced by a pressure from *above* and *below*, the